

## CLAIMS:

1. A continuous flotation process for iron-containing sulphides in ores and concentrates of ores  
5 includes the following steps:
- (a) adjusting the pH of an aqueous pulp of the ores or concentrates of the ores to be in the range of 6.5-8.5;  
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  - (b) adding a reducing agent to modify an iron hydroxide film on the surface of iron-containing sulphides in the ores or ore concentrates to enable adsorption of a collector onto iron-containing sulphides;  
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  - (c) adding the collector to the pulp prior to, during, or after adding the reducing agent in step (b); and  
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  - (d) aerating the pulp to increase the pulp potential to a level sufficient to allow collector adsorption onto the iron-containing sulphides; and  
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  - (e) bubbling gas through the pulp and thereby subjecting the aqueous pulp to froth flotation to produce a froth containing said sulphide containing minerals.  
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2. The process defined in claim 1 includes controlling the addition of the reducing agent in step (b) by reference to the change in pulp potential as the reducing agent is being added in step (b).  
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3. The process defined in claim 1 or claim 2 includes adding a complexant to the pulp prior to or

during step (b) of adding the reducing agent to react with the reduced iron produced in step (b) to minimise iron hydroxide reforming a film on the iron-containing sulphides.

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4. The process defined in any one of the preceding claims wherein the iron-containing sulphides contain one or more valuable metals selected from the group that includes nickel, gold, or platinum group metals.

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5. The process defined in any one of the preceding claims wherein step (a) includes adjusting the pH of the aqueous pulp to be in the range of 7.0-8.0.

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6. The process defined in any one of the preceding claims wherein step (a) includes adjusting the pH of the aqueous pulp to be in the range of 7.1-7.5.

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7. The process defined in any one of the preceding claims wherein step (a) includes adjusting pulp pH by adding acid to the pulp.

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8. The process defined in any one of the preceding claims wherein step (a) includes adjusting pulp pH as the pulp flows through a first tank.

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9. The process defined in any one of the preceding claims wherein step (a) includes controlling the flow of pulp through the first tank to be plug flow.

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10. The process defined in any one of the preceding claims wherein step (b) includes controlling the addition of the reducing agent by adding the reducing agent to the pulp to decrease the pulp potential by at least 150 mV.

11. The process defined in any one of the preceding claims wherein step (b) includes controlling the addition

of the reducing agent by adding the reducing agent to the pulp to decrease the pulp potential by at least 200 mV.

12. The process defined in any one of the preceding  
5 claims wherein step (b) includes controlling the addition of the reducing agent by adding the reducing agent to the pulp to decrease the pulp potential by no more than 350 mV.

10 13. The process defined in any one of the preceding claims wherein step (b) includes intensively mixing the pulp while adding the reducing agent.

14. The process defined in any one of the preceding  
15 claims wherein step (b) includes adding the reducing agent to the pulp as the pulp flows through a second tank.

15. The process defined in any one of the preceding  
20 claims wherein the reducing agent is an oxy-sulphur compound which dissociates in the aqueous media to form oxy-sulphur ions having the general formula



25 where n is greater than 1; y is greater than 2; and z is the valance of the ion.

16. The process defined in claim 15 wherein the oxy-sulphur compound is dithionite.

30 17. The process defined in any one of claims 3 to 16 when dependent directly or indirectly on claim 3 wherein the complexant is selected from the group that includes citric acid and oxalic acid.

35 18. The process defined in claim 17 wherein the complexant is citric acid.

19. The process defined in any one of claims 3 to 18 when dependent directly or indirectly on claim 3 includes adding the complexant to the pulp during step (b) of  
5 adding the reducing agent to the pulp.

20. The process defined in any one of claims 3 to 19 when dependent directly or indirectly on claim 3 includes adding the complexant to the pulp during step (b) of  
10 adding the reducing agent to the pulp as the pulp flows through the second tank.

21. The process defined in any one of the preceding claims wherein the collector is selected from the group  
15 that includes xanthates, dixanthogen, xanthate esters, dithiophosphates, dithiocarbamates, thionocarbamates, and mercaptans.

22. The process defined in claim 21 wherein the  
20 collector is a xanthate.

23. The process defined in any one of the preceding claims wherein step (c) includes adding the collector to the pulp during step (b) of adding the reducing agent to  
25 the pulp.

24. The process defined in any one of the preceding claims wherein step (c) includes adding the collector to the pulp during step (b) of adding the reducing agent to  
30 the pulp as the pulp flows through the second tank.

25. The process defined in any one of the preceding claims includes controlling the process so that the average residence time of pulp flowing through the second  
35 tank is less than 45 seconds.

26. The process defined in claim 25 includes

controlling the process so that the average residence time of pulp flowing through the second tank is approximately 30 seconds.

5 27. The process defined in any one of the preceding claims includes controlling the flow of pulp through the second tank to be plug flow.

10 28. The process defined in any one of the preceding claims wherein step (d) includes aerating the pulp downstream of the second tank.

15 29. The process defined in any one of the preceding claims wherein step (e) includes separating the froth of floated iron-containing sulphides from the pulp and thereafter recovering valuable metals from the froth.

20 30. An apparatus for continuously conditioning iron-containing sulphides in ores in order to facilitate recovery of valuable metals from the floatable iron-containing sulphides, which apparatus includes:

25 (a) a first tank for adjusting the pH of an aqueous pulp of the ores containing iron-containing sulphides as the pulp flows through the tank, the first tank having an inlet for receiving a flow of pulp and an outlet for discharging a flow of pH-adjusted pulp;

30 (b) a second tank for adding a reducing agent and a collector to the pH-adjusted pulp as the pulp flows through the tank, the second tank having an inlet for receiving the flow of pH-adjusted pulp from the first tank, an outlet for discharging a flow of treated pulp from the second tank, a means for

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5                   adding the reducing agent to the second tank, a means for adding the collector to the second tank, and a means for intensively mixing the pulp in the tank; and

10                   (c) a means for aerating the treated pulp from the second tank to allow adsorption of the collector onto the iron-containing sulphides surface.

15                   31.           The apparatus defined in claim 30 wherein the second tank also includes a means for adding a complexant into the second tank.

20                   32.           The apparatus defined in claim 27 or claim 28 wherein the inlet for the pH-adjusted pulp is in the lower section of the second tank and the outlet for treated pulp is in an upper section of the second tank.

25                   33.           The apparatus defined in claim 32 wherein the second tank includes a partition that divides the tank into a lower chamber and an upper chamber and the partition has a central opening that allows flow of pulp between the chambers.

30                   34.           The apparatus defined in any one of claims 30 to 33 wherein the means for adding the reducing agent, the collector, and the complexant to the second tank are adapted to add these reagents to the lower chamber, whereby in use there is thorough mixing of the pulp and the reagents in the lower chamber and plug flow of the pulp and the reagents upwardly through the chambers.

35                   35.           The apparatus defined in any one of claims 30 to 34 wherein the first tank includes a means for venting air from the tank.

36.           The apparatus defined in any one of claims 30 to  
35 wherein the means for aerating the pulp from the second  
tank includes a launder having an aeration screen located  
5   at the outlet of the second tank.